Ask Dr. ALOHA:

Using a Level of Concern in ALOHA

In the previous issue, we discussed how to choose a level of concern, or LOC, for use in ALOHA[1]. In this article, we'll discuss some points to consider when you use LOCs in ALOHA.

Use the right units

First, be sure that your LOC is expressed in units that ALOHA can accept. ALOHA requires LOCs either as parts per million by volume (ppm), or milligrams per cubic meter (Figure 1). Most exposure limits are expressed in one or the other of these units. For example, TLV-STEL values are usually expressed in ppm. To use a TLV-STEL value in ppm as your LOC in ALOHA, just choose **Options** from ALOHA's **Display** menu, type the value into the data field next to "**User-specified conc. of**," then click the **ppm** button.

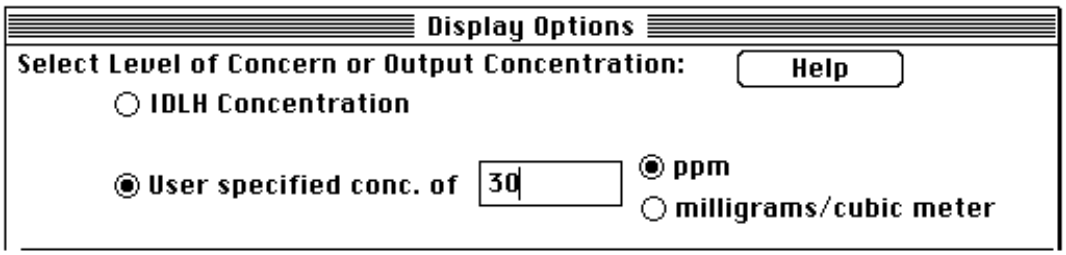

FIGURE 1. ALOHA accepts LOC values only in ppm or milligrams per cubic meter.

However, if you're using an explosive or flammability limit as your LOC, you may need to make a simple units conversion. In CAMEO's RIDS database, and most other information sources, each explosive limit is expressed as a percentage by volume of a vapor in air. For example, the lower and upper explosive limits for acetone are expressed in RIDS as "2.6%" and "12.8%" (Figure 2).

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[1] An LOC is a "threshold concentration" of an airborne pollutant, usually the concentration above which a hazard may exist. ALOHA plots a "**footprint**," which in most cases represents the zone where the ground-level pollutant concentration exceeds your LOC. (A particular kind of footprint, the heavy gas "screening zone," can sometimes overpredict this zone if either release duration is brief or the pollutant is pressurized. See the May/June 1993 issue of CAMEO Today to learn more about this.)

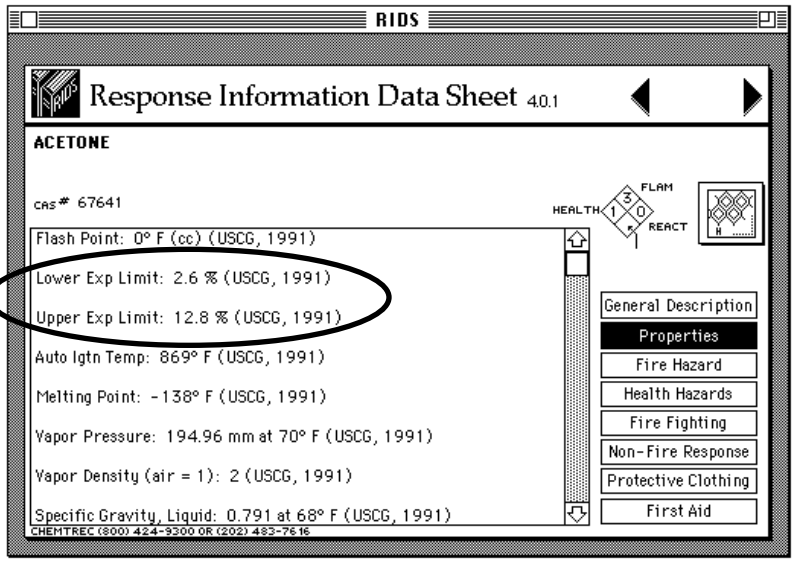

FIGURE 2. Explosive limits for acetone, shown on a card in CAMEO / Mac's RIDS stack. The same information is displayed on the RIDS screen for acetone, accessed from the Chemical Information module of CAMEO / DOS.

You can easily express each of these values in ppm. To do this, just multiply the value by 10,000 (this works because 1% of a million is 10,000, so 10,000 ppm is equivalent to 1%). For example, to express acetone's lower explosive limit, 2.6%, in ppm, make this calculation:

$$2.6\% \times 10{,}000 = 26{,}000 \text{ ppm}$$

Conversion factors that you can use to convert common gas concentration units into units acceptable to ALOHA appear in Table 1, below. To use Table 1, look in the first column to find the units in which your LOC is expressed, then multiply your LOC value by the number shown in the same row in the second column. Your value will then be expressed in the units shown in the same row in the third column. For example, to use an LOC of 0.5 grams per cubic meter in ALOHA, find these units in the first column (they're in the topmost row), then multiply 0.5 by 1,000 (the topmost number in the middle column) to obtain a converted value of 500 milligrams per cubic meter, a value that you can enter into ALOHA

TABLE 1. Units conversion factors for LOC values.

Original value:	Multiply by:	To obtain:
grams per cubic meter	1,000	milligrams per cubic meter
grams per cubic centimeter	1,000,000,000	milligrams per cubic meter
grams per liter	1,000,000	milligrams per cubic meter
pounds per cubic foot	16,018,500,000	milligrams per cubic meter
percent by volume	10,000	parts per million
parts per billion	0.001	parts per million
parts per thousand	1,000	parts per million

Account for contact duration

How badly a person is affected by a chemical depends for the most part on how long the contact lasted and how high the chemical concentration was during that time. For this reason, toxic thresholds have two components: a threshold concentration and a contact duration. The contact duration associated with a particular LOC is part of the definition of that LOC. For example, a chemical's IDLH represents the maximum concentration in the air to which a healthy worker could be exposed *for 30 minutes* without suffering permanent or escape-impairing health effects – so the contact duration for IDLH is 30 minutes.

After an accidental release of a chemical to the air, a cloud of escaped pollutant moves downwind. At any point that the cloud passes over, the gas concentration first rises as the cloud reaches that point, remains high for a time, then drops as the cloud passes by. You can see how ALOHA predicts this will happen at a particular location by examining the **Concentration vs. Time** graph for that point. This graph shows when ALOHA expects the cloud to arrive at the location (that's when the concentration line on the graph begins to rise), how long the concentration will remain high, and when it will begin to drop (that's when the line on the graph begins to fall).

You can use the same graph to account for your LOC's contact duration. To do this, identify locations of concern (such as schools or hospitals) that lie within the footprint. There are several ways to indicate the position of any point to ALOHA so that the program can display a Concentration by Time graph for the location. If you're using a MARPLOT map with ALOHA on a Macintosh, double-click on each location of concern on the map to obtain a Concentration vs. Time graph for that point. If you're using MARPLOT DOS and ALOHA / Windows, position the map marker at the location, then press **SET ALOHA CONC./DOSE POINT**[2]. Otherwise, choose **Concentration** from ALOHA's **Display** menu, then enter the coordinates of each location (check ALOHA's manual to learn more about this). You may also wish to double-click on points along the footprint centerline on ALOHA's footprint plot.

Next, check the graph to see how long your LOC is exceeded at each location. Is your LOC exceeded for longer than the LOC's contact duration? If so, consider this location to be within the predicted hazard zone. For example, Figure 3 is a Concentration vs. Time graph for a location downwind of a particular pressurized ammonia release. A horizontal line representing ammonia's IDLH of 500 ppm, the LOC for this scenario, has been drawn on the graph. The graph shows that ALOHA predicts that, at this location, the outdoor concentration (the upper line on the graph, shown in red on a color monitor) will exceed your LOC only for about three minutes (the length of time represented by the shaded block on the graph). This location does <u>not</u> lie within the predicted hazard zone for

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[2]See the July / August 1993 issue of CAMEO Today to learn more about using ALOHA / Windows with MARPLOT DOS.

your LOC because, although ALOHA predicts that the LOC will be exceeded at this point, it was exceeded for a much shorter time than the LOC's contact duration of 30 minutes. (Be sure also to check the indoor concentration – shown as the lower, blue line on each Concentration vs. Time graph – as well as the outdoor concentration.)

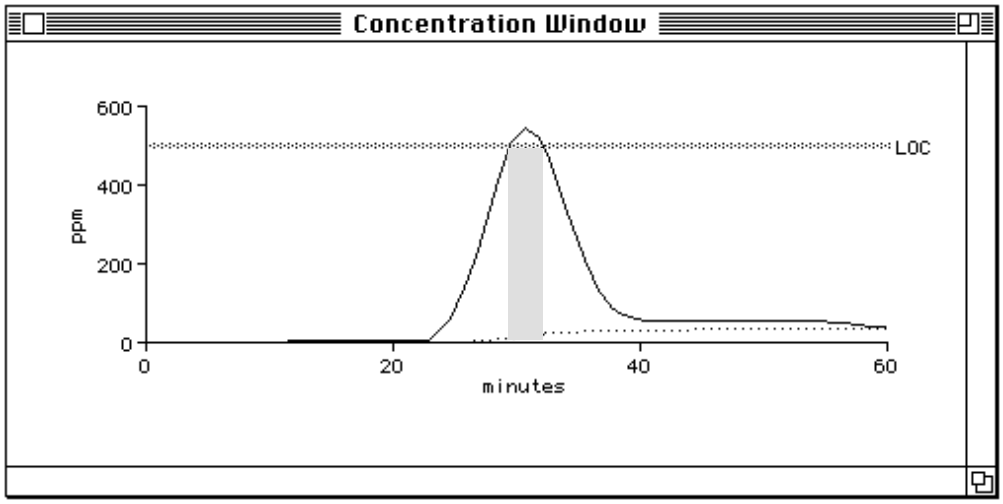

FIGURE 3. Checking predicted exposure duration using a Concentration vs. Time graph for a location downwind of a pressurized ammonia release.

You may sometimes encounter cases in which ALOHA predicts that your LOC will be greatly exceeded at a particular location, but for a time period much shorter than the LOC's contact duration. This combination **does not** imply that no toxic threat exists! Such cases aren't simple to interpret – ask an expert for help.

The bigger the LOC, the smaller the footprint

The size of your LOC has a big effect on the size of ALOHA's footprint. Concentrations of an airborne pollutant are highest near the point of release. They drop as the pollutant cloud travels downwind, because the cloud gradually spreads out and mixes with the air around it. Because concentrations are lower farther from the source, the bigger the LOC that you use, the smaller the footprint, and vice versa. For example, if ALOHA plots a footprint using 1000 ppm as the LOC, that footprint will enclose the area within which concentrations are higher than 1000 ppm. That area will be smaller and closer to the source point than the area that would be included in the footprint if you changed the LOC to 100 ppm.

You may find that more than one exposure limit seems appropriate to use in an ALOHA scenario that you'd like to run. If time permits, run separate footprints using each one. This will allow you to see how much the footprint changes in size as you change LOCs. Figure 4 shows the difference in size of ALOHA

footprints for a particular ammonia release when four common toxic thresholds are used as the LOC: ERPG-3 (1000 ppm), IDLH (500 ppm), EEGL for 1 hour (100 ppm), and TLV-STEL (35 ppm). (Read the article by Nir Barnea in this issue to learn more about these and other threshold values.) If you have identified two or more LOCs that seem appropriate for a particular scenario, and you wish to be conservative (that is, you wish to err on the side of getting too large rather than too small a footprint), you may want to consider choosing a smaller value rather than a larger one.

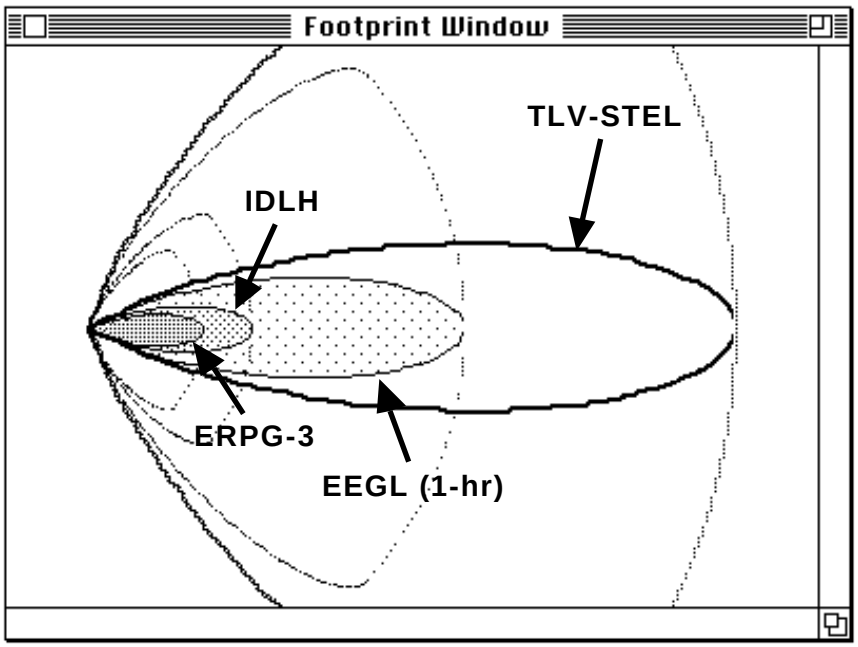

FIGURE 4. ALOHA footprints for an ammonia release, to ERPG-3, IDLH, EEGL (1-hour), and TLV-STEL. (These footprints were overlaid in a graphics application; ALOHA displays only one footprint at a time.)

Likewise, you may sometimes need to decide whether to use a chemical's IDLH as your LOC rather than one-tenth of that IDLH, a value often recommended for planning scenarios. Bear in mind that your choice of one or the other will have a major influence on footprint size. In Figure 5, which shows ALOHA footprints for a particular chlorine release, you can see that choosing one-tenth of the IDLH can give you a much larger footprint than you'll get if you use IDLH as your LOC.

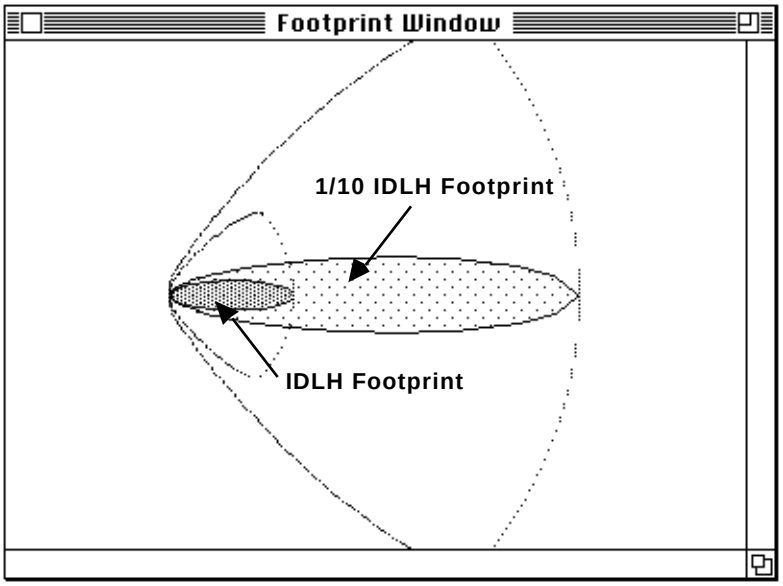

FIGURE 5. ALOHA footprints for a chlorine release, for two LOCs: 30 ppm, the IDLH of chlorine, and 3 ppm, 1/10 IDLH. (These footprints were overlaid in a graphics application; ALOHA displays only one footprint at a time.)

A footprint is a "ballpark estimate"

As you interpret your results from ALOHA, account for the uncertainty associated with your LOC. Toxic thresholds in particular are based on few studies, and represent the effects of pollutants on people, who vary widely in their responses. Even if you feel that you have accurate values for all your other ALOHA inputs, don't forget this source of uncertainty, especially if you're using a toxic threshold as your LOC. Bear it in mind as you examine the footprint plot. Remember that the footprint boundary is not a line separating "safe" from "unsafe." Never forget that an ALOHA footprint is always a "ballpark estimate," never an exact map of the hazard zone for a particular incident!

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